APPENDIX 16
Louisville Metro Hazard Fact Sheets

Louisville Metro's degree of vulnerability depends upon the risk of a particular natural hazard occurring (including such factors as scope, frequency, intensity, and destructive potential), as well as the amount of the population, structures and facilities, economic activity, or environmental resources that are exposed. It is the purpose of the risk assessment to provide the best available information. The following formula method was used to determine an Exposure Score for Louisville Metro.

EXPOSURE SCORE =

Population Rank + Building Rank + Essential Facilities Rank + Utility Facilities Rank + Social Vulnerability Rank + Transportation Rank + Potential High Loss Rank

DEFINITION OF VARIABLES TO DETERMINE EXPOSURE SCORE

1) *Population Rank* – Census tract population taken from Census 2000.

2) *Building Rank* – Real Property Assessments and building content, by parcel, from the Jefferson County PVA data. Plus, a count of buildings built before 1980, when building codes were upgraded.

3) *Essential Facilities Rank* – Census tract count of essential facilities. Data collected from HAZUS-MH, Jefferson County databases, EOP, Jefferson County Schools, LOJIC, Louisville Water Co., EMA, Jefferson County Fire Districts, MSD, and state databases. Essential facilities include: Hospitals, schools, emergency operation centers, fire stations, police stations, and nursing homes.

4) *Utility Facilities Rank* – Census tract count of utility facilities. Data collected from HAZUS-MH, Jefferson County databases, Louisville Water Co, and state databases. Utility facilities include: Communication facilities, electric power facilities, potable water facilities, sewer lines, gas lines, water lines, and waste water treatment facilities

5) *Social Vulnerability Rank* – Total populations numbers, by census tract, of the following:
   - Living with poverty,
   - Female head of household,
   - Renting,
   - Receiving disability assistance,
   - Linguistically isolated,
   - Receiving public assistance
   - No vehicle,
   - Over 65 years old,
   - Manufactured homes
   - Receiving public assistance

6) *Transportation Rank* – Census tract information and total count based on transportation facilities. Data collected from HAZUS-MH, and Jefferson County and state databases. Transportation includes: Airports, bus stations, highway bridges, railroad stations, railroad track footage, and highway footage.

7) *Potential High Loss Rank* – Count of hazardous material storage sites and military instillations within each census tract. This data was derived from Jefferson County databases.

Risk factors are characteristics of a hazard that contribute to the potential losses that may occur in the area. The ***hazard risk gauge*** is a graphic icon used during the initial profile ranking process to convey the relative risk of a given hazard. The scale ranges from green, indicating relatively low or no risk, to red, indicating severe risk.

DAM HAZARD

SUMMARY OF DAM FAILURE RISK FACTORS

Period of occurrence:	At any time
Number of Events to-date	0
Probability of event(s):	Dams that fail, historically, have some deficiency, which caused the failure. Chance of failure increases with heavy rain or earthquake.
Warning time:	Minimal, depends on frequency of inspection.
Potential Impact(s):	Impacts human life and public safety. Economic loss, environmental damage, and/or disruption of lifeline facilities
Cause injury or death	Injury and risk of multiple deaths
Responsible for Monitoring Dam Maintenance	State, MSD, Metro Parks, Corp of Engineers, private owner, and development community
Potential Facility Shutdown	30 days or more

In KY, six dam failures have been reported to the National Performance Dam Program, none in Louisville Metro. Dams are classified based on the evaluation of damage possible downstream. Following is FEMA's guide to dam classifications:

Description of Classification of Dams	
Classification	Description
Class A (Low)	No loss of human life is expected and damage will only occur to the dam owner's property
Class B (Moderate/Significant)	Loss of human life is not probable, but economic loss, environmental damage, and/or disruption of lifeline facilities can be expected
Class C (High)	Loss of one or more human life is expected

Louisville Metro Summary of Dams Class A, B & C			
	Class A (low)	Class B (moderate)	Class C (high)
STATE	18	12	10
		TOTAL	40

A dam failure is usually the result of neglect, poor design, or structural damage. When a dam fails, an excess amount of water is suddenly let loose downstream, destroying anything in its path. Many dams and levees are built for flood protection and usually are engineered to withstand a flood with a computed risk of occurrence. For example, a dam or levee may be designed to contain a flood at a location on a stream that has a certain probability of occurring in any one year. If a larger flood occurs, then that structure may be overtopped. If during the overtopping the dam or levee fails or is washed out, the water behind it is released and becomes a flash flood. Failed dams or levees can create floods that are catastrophic to life and property because of the tremendous energy of the released water.

Louisville Problems: 10 Class C dams, require an Emergency Operation Plan (EOP). State data for dam locations is incomplete. Need a local definition for dams.

DROUGHT HAZARD

SUMMARY OF DROUGHT RISK FACTORS

Period of occurrence:	Summer months or extended periods of no precipitation.
Number of Events to-date	0
Probability of event(s):	Infrequent
Warning time:	Weeks
Potential Impact(s):	Activities that rely heavily on high water usage may be impacted significantly, including agriculture, tourism, wildlife protection, municipal water usage, commerce, recreation, electric power generation, and water quality deterioration. Droughts can lead to economic losses such as unemployment, decreased land values, and Agro-business losses. Minimal risk of damage or cracking to structural foundations, due to soils.
Cause injury or death	No
Potential Facility Shutdown	None

Drought Potential Impacts: High temperatures, prolonged high winds, and low relative humidity can aggravate drought conditions. In Louisville Metro, a secondary effect of a drought could be low river levels on the Ohio River. Low water can become unsafe for navigation in some areas. As a result, fully loaded barges may not be able to safely navigate the river, and tonnage may have to be reduced by 10 to 20 percent.

During periods of drought, some activities that rely heavily on high water usage may be impacted significantly. These activities include agriculture, tourism, wildlife protection, municipal water usage, commerce, recreation, wildlife preservation, electric power generation, and water quality deterioration.

Droughts can lead to economic losses such as unemployment, decreased land values, and Agro-business losses. In addition, there is minimal risk of damage or cracking to structural foundations, due to soils.

Louisville Problems: Need more data for assessment. No standard definition of a drought. No one agency/organization is tracking drought.

EARTHQUAKE HAZARD

SUMMARY OF EARTHQUAKE RISK FACTORS

Period of occurrence:	Year-round
Number of Events to-date	0
Probability of event(s):	Infrequent
Warning time:	None
Potential Impact(s):	Impacts human life, health, and public safety. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Can cause severe transportation problems and make travel extremely dangerous. Aftershocks and secondary events could trigger landslides, releases of hazardous materials, and/or dam and levee failure and flooding.
Cause injury or death	Injury and risk of multiple deaths.
Potential Facility Shutdown	Months

Earthquakes can be experienced in any part of Kentucky, putting Kentucky's entire population and building stock at risk. Each county has at least one fault running beneath it. The greatest hazard potential for earthquakes exists in highly populated areas, because these areas tend to have a greater number of tall buildings that are more vulnerable to seismic impact. Buildings and infrastructure (roads, bridges, etc.) built during the 1920s to 1960s are also generally more susceptible to seismic movement than newer construction.

Louisville Metro Potential Earthquake Damage: Areas of softer soil and potential liquefaction generally result in increased vulnerability to the impacts of an earthquake. In Louisville Metro, old portions of the city and heavy industry are located on the alluvial deposits adjacent to the Ohio River. New portions of the city, including malls and the surrounding suburbs are constructed on the clay materials derived from limestone bedrock. Available soil maps and data from the Kentucky Geological Survey only represent approximately one-third of the metro area were available.

The HAZUS-MH pilot program results show that an earthquake of 8.6 M in the New Madrid seismic zone would result in structural building damage ranging from minor to significant extending well into the Louisville Metro area. A similar earthquake magnitude event in the western U.S. would impact a much more limited geographic area. Earth scientists estimate that enough energy has built up in the New Madrid seismic zone to produce an earthquake with a 7.6*M*. Everyone in Kentucky could feel such a quake, while the Louisville Metro area would experience the effects at a Modified Mercalli Intensity Zone 7. The effects of such an earthquake could include: (1) ruptured pipelines, (2) downed electrical and communication lines, (3) releases of hazardous materials, (4) fires, (5) collapsed bridges and overpasses, and (6) damaged or destroyed critical facilities.

Louisville Problems: need better data on soils for liquefaction to be able to run a true model of an earthquake.

EXTREME HEAT HAZARD

SUMMARY OF EXTREME HEAT RISK FACTORS

Period of occurrence:	Summer
Number of Events to-date:	6 deaths 1999- 2002
Probability of event(s):	Likely
Warning time:	Several days of high temperatures hovering over 90 degrees.
Potential Impact(s):	Public health and safety, especially the elderly. Heavy use of water and electrical facilities due to air conditioners, fans, etc…
Cause injury or death	Injury and risk of multiple deaths
Potential Facility Shutdown	None

Background: Temperatures that hover 10 degrees or more above the average high temperature for the region are defined by NOAA as extreme heat. A temperature of 90°F is significant in that it ranks at the "caution" level of the NOAA's Apparent Temperature chart even if humidity is not a factor. At-risk during extreme heat are the elderly and the homeless.

July 1999 Heat Wave: During the last two weeks of July 1999, the Midwest experienced a lengthy series of days with temperatures in excess of 90F. Before it was over, some 232 deaths were attributed to the heat in the 9-state Midwest region. Louisville Metro had four deaths in 1999.

Louisville Problems:

- Lack of data to Profile Extreme Heat, due to no long-term tracking Extreme Heat and deaths.

FLOOD HAZARD

SUMMARY OF FLOOD RISK FACTORS

Period of occurrence:	Ohio River: January through May Flash Floods: anytime, but primarily during Summer rains
Number of Events to-date: 1950 - 09/30/2004	29 NCDC 4 local
Probability of event(s):	Highly likely
Warning time:	River flooding – 3 –5 days Flash flooding – minutes to hours Out-of-bank flooding – several hours/days
Potential Impact(s):	Impacts human life, health, and public safety. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Can lead to economic losses such as unemployment, decreased land values, and Agro-business losses. Floodwaters are a public safety issue due to contaminants and pollutants.
Cause injury or death	Injury and risk of multiple deaths
Potential Facility Shutdown	Weeks to months

Flooding is Kentucky's most costly natural disaster. For many, the economic, social, and physical damage resulting from floods can be severe. Analysis performed for the local Floodplain Management Plan indicated the three watersheds with the greatest risk for loss of life and/or property damage relative to number of buildings and primary structures is Pond Creek, Beargrass Creek, and Mill Creek. Floyds Fork and North County are less developed and populated.

Repetitive Loss: Louisville Metro has the highest number of repetitive loss properties in Kentucky with 167 Repetitive Loss Properties, according to the 2004 National Flood Insurance Program (NFIP) insurance claims. Based on an analysis of repetitive loss sites, the North County watershed, along the Ohio River, represents an area of extraordinary high risk, although there are a relatively low total number of structures in the floodplain. Other repetitive loss areas are also at-risk due to tributaries, ponding and drainage problems.

Existing Buildings Located in Floodplain by Occupancy Class

Occupancy Class	Total # of Buildings	Total Property Value*
AGRICULTURAL	67	$18,818,360
COMMERCIAL	893	$1,080,598,515
EDUCATION	19	$28,852,060
GOVERNMENT	364	$55,076,950
INDUSTRIAL	189	$1,477,984,910
RELIGIOUS	195	$89,659,710
RESIDENTIAL	9215	$2,567,722,775
TOTAL	10942	$5,318,713,280

Floodplain Management Plan

The local floodplain management plan adopted in 2001 estimated the total buildings at risk for the 100-year flood as approx 6 %. This result aligns with the HAZUS-MH result (approx 6.8 % of buildings).

*the sum of content and improved property value

HAILSTORM HAZARD

SUMMARY OF HAILSTORM RISK FACTORS

Period of occurrence:	Year-round
Number of Events to-date: 1950 - 06/30/2004	59 NCDC
Probability of event(s):	Likely, usually associated with severe thunderstorms.
Warning time:	Minutes to hours
Potential Impact(s):	Large hailstorms can include minimal to severe property and crop damage and destruction.
Cause injury or death	Injury
Potential Facility Shutdown	Days

According to the NOAA, 1,972 reported hailstorms have happened in Kentucky since 1980. These storms of varying sized hail have caused $1.3 billion worth of property damage and $5.4 million worth of crop damage.

KARST/ SINKHOLE HAZARD

SUMMARY OF KARST/SINKHOLE RISK FACTORS

Period of occurrence:	At any time
Number of Events to-date	Unknown. 451 mapped sinkholes
Probability of event(s):	Infrequent
Warning time:	Weeks to months, according to monitoring or maintenance.
Potential Impact(s):	Economic losses such as decreased land values and Agro-business losses. May cause minimal to severe property damage and destruction. May cause geological movement, causing infrastructure damages.
Cause injury or death	Injury
Potential Facility Shutdown	Days to weeks

Kentucky contains one of the world's largest Karst-ridden topographies. About 38% of the state has sinkholes that are recognizable on topographic maps, and 25% has obvious and well-developed Karst features. The surface expression of Karst includes sinkholes, sinking streams and springs. Karst hazards include: sinkhole flooding, sudden cover collapse, leakage around dams, and collapse of lagoons resulting in waste spills and radon infiltration into homes.

Louisville Metro is vulnerable to karst and sinkhole flooding. Sinkholes are among the most common problems of living in a karst area. Louisville has 451 mapped sinkholes according to LOJIC. Damage to infrastructure from sinkhole flooding and cover collapse is so common in Kentucky that it is typically dealt with by local authorities as a routine matter.

Existing Buildings Located in Karst/Sinkhole Region by Occupancy Class

Occupancy Class	Total # of Buildings	Total Property Value*
AGRICULTURAL	1302	$302,524,630
COMMERCIAL	4551	$3,935,305,090
EDUCATION	288	$296,547,520
GOVERNMENT	537	$466,568,290
INDUSTRIAL	466	$2,912,578,380
RELIGIOUS	3106	$1,169,375,172
RESIDENTIAL	116553	$26,122,494,766
TOTAL	126803	$35,205,393,848

*the sum of content and improved property value

Louisville Problems: More data is needed to model the effects of karst and sinkholes. Karst and sinkhole incidents are not tracked by one agency and needs coordination.

LANDSLIDE HAZARD

SUMMARY OF LANDSLIDE RISK FACTORS

Period of occurrence:	Chance of occurrence increases after heavy rainfall, snowmelt, or construction activity. Most landslides happen between spring and fall.
Number of Events to-date:	4 +
Probability of event(s):	Slope failures usually caused by rain, snow, or freezing and thawing of soil water. SW portion of county is more prone to landslide due to slope. Probability increases at the base of steep slope; the base of drainage channel; and developed hillsides where leach-field septic systems are used.
Warning time:	Weeks to months, depends on inspection for weaknesses in rock and soil. Some landslides cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.
Potential Impact(s):	Economic losses such as decreased land values, disruption of utility and transportation systems, and costs for any litigation. May cause geological movement, causing infrastructure damages ranging from minimal to severe.
Cause injury or death	Injury
Potential Facility Shutdown	Days to weeks

Factors that allow landslide movement include: saturation by water, steepening of slopes by erosion or construction, alternate freezing or thawing, and earthquake shaking. Slope failures can occur in any season, but are more likely to be triggered by weather events such as rain, snow, or freezing and thawing of soil water. During summer and fall, intense or prolonged rainfall can trigger slope failures.

Landslides are more likely to occur in the SW portion of the county due to slope and unstable soils: Probability increases at the base of a steep slope; the base of a drainage channel; and developed hillsides where leach-field septic systems are used. Several studies have shown that almost any modification of a slope by people increases the risk of slope movement, especially in areas already susceptible. Flood insurance does not cover landslides. Private costs involve mainly damage to land and structures. A severe landslide can result in financial ruin for the property owners. Individuals can take steps to reduce their personal risk.

- Steep slopes are more susceptible to landslides and should be avoided as a building site.
- Slope stability decreases as water moves into the soil. Springs, seeps, roof runoff, gutter down spouts, septic systems, and site grading that cause ponding or runoff are sources of water that often contribute to landslides.
- Changing the natural slope by creating a level area where none previously existed adds weight and increases the chance of a landslide.

- Poor site selection for roads and driveways.
- Improper placement of fill material.
- Removal of trees and other vegetation.

Existing Buildings Located in Landslide Area by Census Tract

Census Tracts	Total # Buildings	Total Property Value*
009104	60	$62,938,210
011901	39	$10,577,865
012001	237	$38,671,105
012002	49	$7,302,585
012003	297	$37,873,635
012105	257	$56,147,690
012202	175	$24,212,070
012203	388	$79,038,380
012204	469	$130,114,100
012301	134	$19,500,320
012302	237	$101,911,480
TOTAL	2,342	$568,287,440

*the sum of content and improved property value

Existing Buildings Located in Landslide Area by Occupancy Class

Occupancy Class	Total # of Buildings	Total Property Value*
AGRICULTURAL	40	$6,665,990
COMMERCIAL	24	$25,714,850
GOVERNMENT	23	$3,062,420
INDUSTRIAL	1	$7,894,250
RELIGIOUS	24	$3,647,700
RESIDENTIAL	2230	$521,302,230
TOTAL	2,342	$568,287,440

*the sum of content and improved property value

SEVERE STORMS HAZARD
THUNDERSTORMS AND LIGHTNING

SUMMARY OF SEVERE STORMS RISK FACTORS

Period of occurrence:	Spring, Summer and Fall
Number of Events to-date: 1950 - 09/30/2004	Thunderstorms NCDC: 176 Lightning NCDC: 8
Probability of event(s):	Frequent
Warning time:	Minutes to hours
Potential Impact(s):	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases. Impacts human life, health, and public safety.
Cause injury or death	Injury and risk of multiple deaths
Potential Facility Shutdown	Days to weeks

In Kentucky, between 1996 and 2003, there have been eleven Presidential Declarations due to severe storms and other storm-related events. The Midwest and Great Plains regions of the U.S. average between 40 and 60 days of thunderstorms per year. These two regions are prone to some of the most severe thunderstorms on Earth.

Potential Impacts of Severe Storms: Due to the destructive nature of thunderstorms and lightning these events impact human life, health, and public safety. The community is at-risk for: utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, fire, damaged or destroyed critical facilities, and hazardous material releases.

Preparedness includes planning for emergency shelters and power outages.

SEVERE WINTER STORM HAZARD
SNOW AND ICE

SUMMARY OF SEVERE WINTER STORMS RISK FACTORS

Period of occurrence:	Winter
Number of Events to-date: 1950 - 09/30/2004	7 local and NCDC
Probability of event(s):	Likely
Warning time:	Days for snow Minutes to hours for ice.
Potential Impact(s):	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, and damaged or destroyed critical facilities Can cause severe transportation problems and make travel extremely dangerous. Power outages, which results in loss of electrical power and potentially loss of heat, and human life. Extreme cold temperatures may lead to frozen water mains and pipes, damaged car engines, and prolonged exposure to cold resulting in frostbite.
Cause injury or death	Injury and slight risk of death. Significant threat to the elderly.
Potential Facility Shutdown	Days

Kentucky's location makes it vulnerable to heavy snowfall due to the state's proximity to the Gulf of Mexico, which provides a necessary moisture source, yet it is far enough north to be influenced by polar air masses. Low-pressure systems that bring heavy snow to Kentucky usually track eastward across the southern U.S. before turning toward the northeast.

Potential Impact to Louisville Metro: The level of impact severe winter weather will have upon a community greatly depends on its ability to manage and control its effects, such as the rapid mobilization of snow removal equipment. Louisville Metro has experienced several crippling winter storms over the years, which is common to the region due to its geographical location. It is expensive to acquire and maintain

the necessary resources to combat winter's effects such as generators, snow removal equipment, and trucks. Preparedness includes, planning for emergency shelters and power outages.

TORNADO HAZARD

SUMMARY OF TORNADO RISK FACTORS

Period of occurrence:	Year-round, primarily during March through August
Number of Events to-date: 1950 – 9/30/2004	9
Probability of event(s):	Infrequent
Warning time:	Minutes to hours. Over 80 % of all tornadoes strike between noon and midnight.
Potential Impact(s):	Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, and damaged or destroyed critical facilities. Impacts human life, health, and public safety.
Cause injury or death	Injury and risk of multiple deaths
Potential facilities shutdown?	30 days or more

What Is A Tornado? A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. It is spawned by a thunderstorm (or sometimes as a result of a hurricane) and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. The damage from a tornado is a result of the high wind velocity and wind-blown debris. Tornado season is generally March through August, although tornadoes can occur at any time of year.

The occurrence of a Kentucky tornado is predictable because a tornado touches down somewhere in the Commonwealth every year. Tornadoes have caused $707.7 million in property damage, $186,000 in crop damage, 115 deaths, and 2,593 injuries. Kentucky is located in the most severe wind zone (ZONE IV 250 mph) in the country. This signifies that most of the state is highly vulnerable to tornadic weather. Tornadoes are somewhat common throughout Kentucky and have occurred in every month of the year. Conversely, the occurrence of a tornado is highly unpredictable in it is impossible to forecast the exact time and location that it will touch down and the path that it will take

Most tornadoes occur between March and July, with the month of May normally experiencing the greatest number of tornadoes. The strongest tornadoes, which usually result in the highest

number of deaths and greatest destruction of property, occur between April and June. Most deaths occur in April, which is considered the beginning of the tornado season.

Tornado Potential Impact: Due to the destructive nature of tornadoes and wind, these events impact human life, health, and public safety. Community-wide impacts include: utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, and damaged or destroyed critical facilities. Tornadoes can also cause severe transportation problems and make travel extremely dangerous.

WILDFIRE HAZARD

SUMMARY OF WILDFIRE RISK FACTORS

Period of occurrence:	Year-Round, primarily Summer
Number of Events to-date	0 forest fires
Probability of event(s):	Chances of occurrence increase with drought or earthquake.
Warning time:	None, unless related to drought. Humans, through negligence, accident, or intentional arson, have caused approximately 90% of all wildfires in the last decade.
Potential Impact(s):	Impacts human life, health, and public safety. Loss of wildlife habitat, increased soil erosion, and degraded water quality. Utility damage and outages, infrastructure damage (transportation and communication systems), structural damage, damaged or destroyed critical facilities, and hazardous material releases.
Cause injury or death	Injury and risk of death
Potential facilities shutdown?	30 days or more

Since 1977, Kentucky has experienced 2,033 reported wildfires and 78,710 acres burned. Approximately 86% of these fires were caused by humans, and of those approximately 50% were arson. The damage to Kentucky's timber resource is valued at $85.58 per acre. This is an average yearly loss of $6,736,001. This figure does not account for the loss of wildlife habitat, increased soil erosion, and degraded water quality.

Wildfire is listed in the Louisville Metro EOP and the potential for wild or grass fire is apparent. However, local records of wild fire incidents are limited. Until better data is gathered, Project Staff determined the best way to quantify wildfire potential is to target vulnerable areas according to tree cover. Staff determined to map tree cover that is 3-acres or more as vulnerable or at-risk.

Louisville problems: Need better data from Fire Departments about grass and wildfire. Need a standard code for reporting the type of fires.

HAZARD PROFILE RANKING FOR 12 NATURAL HAZARDS

The Risk Matrix provides a qualitative assessment of various hazards that could occur.

SEVERE RISK HAZARDS	FLOODING SEVERE THUNDERSTORMS
HIGH RISK HAZARDS	HAILSTORM TORNADO
MODERATE HAZARDS	EARTHQUAKE SEVERE WINTER STORMS
LIMITED RISK HAZARDS	DAM FAILURE EXTREME HEAT KARST/SINKHOLE LANDSLIDES WILDFIRE
LOW RISK HAZARDS	DROUGHT